

**A PRACTICAL TREATISE ON THE  
MOVEMENT OF SLIDE VALVES BY  
ECCENTRICS; FOR  
THE USE OF ENGINEERS,  
DRAUGHTSMEN, MACHINISTS, AND  
STUDENTS IN GENERAL**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649484225

A Practical Treatise on the Movement of Slide Valves by Eccentrics; For the Use of Engineers, Draughtsmen, Machinists, and Students in General by C. W. Mac Cord

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**C. W. MAC CORD**

**A PRACTICAL TREATISE ON THE  
MOVEMENT OF SLIDE VALVES BY  
ECCENTRICS; FOR  
THE USE OF ENGINEERS,  
DRAUGHTSMEN, MACHINISTS, AND  
STUDENTS IN GENERAL**



A  
PRACTICAL TREATISE  
ON THE  
MOVEMENT OF SLIDE VALVES  
BY  
ECCENTRICS.

FOR THE USE OF

ENGINEERS, DRAUGHTSMEN, MACHINISTS, AND STUDENTS  
IN GENERAL.

BY

C. W. MAC CORD, A. M.,

PROFESSOR MECHANICAL DRAWING, STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, N. J.

ILLUSTRATED BY 8 FULL PAGE COPPERPLATES.

NEW YORK:

D. VAN NOSTRAND, PUBLISHER, 25 MURRAY AND 27 WARREN STREET.  
1878.

Eng. 1838.73.3 F  
( 1 )

JUN 20 1917  
TRANSFERRED TO  
CENTRAL COLLEGE LIBRARY

U.F.C.F.  
31.23  
3

Entered according to Act of Congress, in the year 1878, by  
D. VAN NOSTRAND,  
in the Office of the Librarian of Congress at Washington.

# CONTENTS.

## CHAPTER I.

### GENERAL INVESTIGATION OF THE "ECCENTRIC MOTION."

"Slide Valve" Defined.—Identity of Crank and Eccentric.—Oblique Action of Finite Connecting Rods.—Means of Neutralizing the Effects.—The Slotted Cross-head.—Nature of the Motion imparted by the Eccentric.—Greatest Breadth of Port.—Least Breadth of Valve.—First Mode of Action.—Port Opened and Closed from the same Edge.—Conditions of Action when Port leads directly into Cylinder.—Effect of Reducing Port.—Conditions of Action when Port leads into Valve Chest.—Limits of Breadth of Port and of Valve under these conditions.—Effect of Reducing Port and of Extending Valve.—Second Mode of Action.—Port Opened and Closed by Perforated Valve.—Limits of Breadth of Port and of Valve-faces.—Effect of Reducing Port.—The Three Valves Contrasted.—Relation of Chords of Action to the Line of Motion.—Synoptical Comparison of the Three Forms of Valve.

## CHAPTER II.

### OF THE ACTION OF THE VALVE, AS APPLIED TO A SINGLE STREAM PORT.

Action of a Steam Valve governing One Port.—Full Stroke Valve without Lead.—Limits of Breadth of Port and Valve.—Angular Position of Eccentric Defined.—Mode of Determining it.—Valve Arranged to Cut Off.—"Lap" an Effect, not a Cause.—To find the Point of Cutting Off, the Travel and Port Opening being given.—To find the Port Opening, the Travel and Point of Cutting Off being given.—To find the Travel, the Port Opening and the Point of Cutting Off being given.—Effect of Lap considered in regard to a given Port.—Various Modes of Constructing the Valve Movement.—Angular Position of Eccentric for a given Point of Cutting Off, the same with any Travel.

## CHAPTER III.

### THE ACTION OF THE EXHAUST VALVE, OF THE THREE-PORTED OR COMMON SLIDE VALVE, AND OF THE TWO-PORTED OR BOX VALVE.

Action of the Valve applied to an Exhaust Port.—One Valve may govern Two Ports, at Opposite Ends of the Cylinder.—These may be both Steam Ports, both Exhaust Ports, or one for Steam and the other for Exhaust.—In the latter case, Exhaust Action deranged if the Valve cuts off.—Of the Three-ported or Common Slide.—Composed, in fact, of Four Valves.—

Action Perfect for Full Stroke.—Derangement caused by making Steam Side cut off.—“Lead” Explained.—Its Effect on a Full Stroke Valve.—Effect on the Cutting Off Point.—To make a Valve cut off at a given Point, with a given Lead.—“Minus Lap:” its Effects and Limits.—Further Consideration of Derangement of Exhaust Action.—“Adding Lap.”—Sum of Lap and Lead on the two Sides always Equal.—General Construction of Complete Movement of the Three-ported Slide.—Of the Two-ported, or “Box” Valve.—General Construction of its Movement.

## CHAPTER IV.

## OF INDEPENDENT CUT-OFF VALVES.

Objection to the “Independent Exhaust Valve.”—First Form of Independent Cut-off Valve, on Back of Main Valve Chest—Its Duty and Mode of Action.—Advantages of this Device.—Action Similar to that of Steam Valve before described.—Connection of several Valves together.—Advantages of this “Gridiron” Form.—Construction of the Movement to cut off at a given Point with a given Lead.—To Adapt a Valve to a given Seat.—To Change the Point of Cutting Off.—Limits of such Variation.—To make a given Valve cut off at any Point within these Limits.—Second Form of Independent Cut-off Valve.—To Construct the Movement, the Lead and Cutting-off Point being fixed.—“Gridiron” Form of this Valve.—Ports not necessarily Equal.—To Adapt a Valve to a given Seat.—To Vary the Point of Cutting Off.—To make a given Valve cut off at a given Point, with a stated Lead.—Contrast between the Two Forms of Valve.—Cut-off Valve on Back of Main Valve.—Action the same as if the Seat were Fixed.—Illustration of the Movement derived from Two Eccentrics.—Explanation of its Construction.—To Vary the Point of Cutting Off, without Stopping the Engine.—Perforated Valve may also be used on Back of Main Valve.—Construction of the Movement.

## CHAPTER V.

## THE ANGULAR VIBRATIONS OF THE MAIN CONNECTING ROD AND THE ECCENTRIC ROD.

Effect of the Oblique Action of Finite Connecting Rod.—Difference between Direct and Back-acting Engines.—Effect of Lead under the new Condition.—Effect of the Finite Connecting Rod on the Time of Closing the Ports.—Mode of Equalizing Power developed in each Stroke by Changing Position of Valve Seat.—Equalization of Cut-off Points by making Lead Unequal.—The same with Independent Cut-off Valve.—Equalization of Exhaust Closure.—Inequality in Port Opening unavoidable.—Equalization of Action of Cut-off Valve of the Third Form.—Effect of the “Vibration” of the Eccentric Rod: First on a Full-stroke Valve without Lead.—The same with Lead.—Cut-off Points can be Equalized only by making Lead Unequal.—Construction of Movement when a Definite Lead is to be given on one Stroke.—To Equalize the Cut-off and the Exhaust Closure of the Main Valve.—To Equalize the Action of the Perforated Cut-off Valve.—The same with a Definite Lead on one Stroke.



## PREFATORY REMARKS.

---

The action of the slide valve of the steam engine, operated through various intervening devices by a motion derived from an eccentric, has been so often and so ably discussed, that in presenting a new treatise on the subject, an explanation seems called for, offering an excuse for its appearance. The object of the present work is that of aiding practical engineers in forming a clear idea of, first, the nature of the motion, and what the valve *can* be made to do; second, the requirements of the engine, and what the valve *must* be made to do; and, third, the construction of the movement, and how to make the valve do what it is to do. And the plea for its existence, upon which main reliance is placed, rests primarily on the manner in which these questions are presented.

Much labor and zeal have been expended, not to say wasted, in treating this matter analytically—the method being to embody the elements, constant and variable, of the whole combination, including all the connecting rods, cranks, eccentrics, rock shafts, links, and levers, making up the working gear interposed between the piston and the valve, in an equation expressing the movement as influenced by them all; and by discussing this equation to deduce results as affected by various supposed changes in the proportions or relations of these elements.

The subject affords a good field for the display of analytical acumen; and this method of employing algebraic skill for a practical purpose is at once elegant and refined; but such investigations do not answer the purposes above set forth; admirable as they may be intrinsically, they are so mainly to the select few as interesting studies of applied mathematics.

It must be borne in mind that of those who study closely the mechanical movements of the steam engine, particularly those who are directly interested in the practical matter of engine building—the draughtsmen who design as well as the mechanics who execute—the great majority are not versed in the higher mathematical branches. And more especially is it true that they are seldom of the order of mind which turns naturally to analysis as a mode of solving problems; the *geometrical* reasoners are the ones most likely to adopt a profession in which graphic methods are in constant use, and to many, proficient in these, any thing written in the language of symbols is a sealed book, while to many more it is a very dry one.

Again, the connection between an abstract formula and its concrete embodiment is so indirect and obscure, that even those competent to trace the equation through its various transformations from the initial to the final stage, have frequent need to resort to graphic means of illustrating their progress, and are absolutely driven back to them in order to construct their ultimate expressions, and reduce their theoretical deductions to a practical form.

It is to be considered, too, that the engine itself is not a creature of analytical instincts; its parts move with geometrical precision, in lines and about centres which, having fixed linear relations to each other, are just as susceptible of accurate delineation on paper as of accurate adjustment in metal; they did so before their motions were analyzed, and would continue to do so to the end of time, though the art of analysis were forgotten. In fact, the mathematical education of the engine has never gone beyond geometry; it was planned by geometry, it was built by geometry, and it runs by geometry. To be sure, you may examine it analytically, and formulate the results; but, algebra or no algebra, it will answer no questions which it cannot answer by geometry.

Since, then, the valve movements must eventually be constructed by graphic processes, whether they be previously discussed analytically or not, there seems to be no good reason why the former method should not be separately used in the whole investigation.

On the contrary, it would appear from the preceding considerations that it is peculiarly adapted, not only to the elucidation of this subject, but to the tastes of those specially addressed; it has, therefore, been adopted, to the entire exclusion of algebraic analysis, which those who prefer it may find exhaustively used in other works.

In regard to the general arrangement and subdivision of the matter presented, it is proper to remark that, in the author's opinion, the chief source of the difficulty often found in imparting, even by the graphic method, a thorough insight into the action of the slide valve, and the construction of its movement, is to be found in the fact that usually the investigation starts out with the three-ported or common slide, very often miscalled "the simplest form of the valve;" and introduces at once the several adjuncts of "lap," "lead," "inside clearance," etc., which, though simple enough when separately considered, are bewildering to the beginner when he is at once confronted with them all.

By dissecting this valve, and considering its members and their functions one by one, the author has endeavored to make their combined action more readily comprehended.

НОВОКЕН, Feb. 1873.